401A and 401AR

Du Mont

SERVICE and CALIBRATION MANUAL

FAIRCHILD

INSTRUMENTATION

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

750 BLOOMFIELD AVE., CLIFTON, NEW JERSEY

Scientific Instrument Service Department

MP MASTER

MA29967

CATHODE-RAY TUBE

TYPE..... 5ADP- operated at a total accelerating potential of approximately 3000 volts

CRT SCALE..... Engraved edge-lit scale and appropriate color filter over face of tube. Dimmer control varies illumination level from zero to intensity adequate for photographic recording

2. VERTICAL AMPLIFIER

INPUT COUPLING

a. Single-ended signal..... Direct or through capacitor of 600-volt rating to amplifier

b. Balanced Signal..... Available at .01 D-C position of Y VOLTS/CENTIMETER switch

c. Direct to Deflection Plates..... Provision is made for dc connection to the deflection plates. For best focus, an average dc potential of 265 volts with respect to ground should be maintained

d. Maximum Permissible Signal..... 600 volts (sum of signal + dc)

INPUT ATTENUATION..... Provided by a frequency compensated attenuator with steps corresponding to full scale voltages of .01, 0.1, 1.0, and 10 volts $\pm$2%; OFF position is provided

INPUT IMPEDANCE

a. Through Amplifier

Single-ended ..... 2 megohms, 55 uuf maximum

Balanced ..... 2 megohms, 55 uuf maximum each side to ground

b. Direct to Deflection Plates

Single-ended ..... No greater than 5 megohms should be used (Deflection plate return resistors are not supplied)

Balanced ..... No greater than 10 megohms center-tapped to ground should be used (Deflection plate return resistors are not supplied)

SINUSOIDAL FREQUENCY RESPONSE
(Referred to sensitivity at 1 Kc)

a. High Frequency ..... Down not more than 30% at 100 Kc

b. Low Frequency

Direct coupled ..... Flat to dc

Capacitively coupled ..... Down not more than 10% at 2 cycles

PULSE RESPONSE (to a step function)

a. Rise Time ..... 3.5 microseconds or less

b. Overshoot ..... 2% or less

c. Decay at top

Direct coupled ..... None

Capacitively coupled ..... 10% in 20 milliseconds nominal

DEFLECTION SENSITIVITY

a. Through Amplifier (at full gain) ..... 1 cm minimum deflection from 0.01 dc volt

b. Direct to Deflection Plates .... 12 to 15 dc volts per cm

EXPANSION AND POSITIONING.... Any portion of three times full scale deflection can be positioned on screen. Undistorted deflection is available over the visible portion of the trace at any position-control setting, provided that sensitivity is not decreased to less than 20% of maximum sensitivity. With sensitivity reduced to less than 20% of rated sensitivity, undistorted deflection is limited to approximately twice full screen

LINEARITY OF ON-SCREEN DISPLAY

a. Amplifier ..... 1% of voltage for full scale on-screen deflection (with sensitivity set to 20% or more of rated sensitivity). Not worse than 10% difference between any 10% increments of voltage that produces full scale on-screen deflection.

b. Display (Amplifier linearity as viewed on CRT)..... 5% of deflection for 7.5 cm, +3.75 cm from center screen (within the limits of a 7.5 cm x 7.5 cm centered square with edges parallel to the X and Y axis with sensitivity set to 20% or more of rated sensitivity). Not worse than 10% difference between any 10% increments.

COMMON MODE

a. Common Mode Rejection ..... Approximately 400 to 1 at maximum Y AMPLITUDE setting. (Y BAL and Y POSITION controls adjusted for maximum common mode rejection ratio)

b. Maximum Common Mode Signal..... 1 volt peak-to-peak

STABILITY

a. Varying Line Voltage (± 10%) ..... Drift does not exceed a total of 2 cm (plus and/or minus 1 cm from screen center) in an 8-hour period

b. Constant Line Voltage ..... Drift does not exceed a total of 1 cm in an 8-hour period

HORIZONTAL AMPLIFIER

(Identical to vertical amplifier except as shown)

DEFLECTION SENSITIVITY

a. Through Amplifier (At full gain) ..... 1 cm minimum deflection from 0.01 dc volt input

b. Direct to Deflection Plates ..... 16 to 20 dc volts per cm

BEAM GATE ..... Automatic beam brightening during forward sweep. Beam is not visible during sweep retrace or while sweep is at rest. INTENSITY control overrides blanking for X-amplifier use

The beam gate may be used to gate the beam on for a time interval determined by the SWEEP RANGE and VERNIER controls when the X amplifier is being used

X & Y AMPLIFIER RELATIVE PHASE SHIFT CHARACTERISTICS (DC COUPLED)

a. Any Combination of X & Y AMPLITUDE Settings ..... Phase shift does not exceed 1° below 2.5 Kc

b. X & Y AMPLITUDE Set at Maximum ..... Phase shift does not exceed 3° below 100 Kc

AMPLITUDE CALIBRATION CIRCUIT

VOLTAGE CALIBRATOR

a. Waveshape and Frequency... Clipped sine wave at power-line frequency

b. Amplitude ..... 50 mv peak-to-peak ±2% is provided for each amplifier independently

c. Availability..... By means of the X CAL or Y CAL push-push switch which automatically disconnects the input from the amplifier and inserts the calibration signal. X calibrator is inoperative when DRIVen or AUTOmatic sweep is in use

SWEEP CIRCUIT

MODE	Vacuum tube sweep, driven or automatic as desired
SWEEP WRITING RATE	
a. Internal	
Calibrated	From 250 milliseconds to 5 microseconds per cm in 7 steps, with multipliers of 1, 2, and 5
Uncalibrated	Continuously variable from 250 milliseconds to 5 microseconds per cm
Accuracy	±5% on all ranges within center half scale
b. External	EXT SWP CAP terminals are provided (rear panel) for slower sweeps. See Section 2, Operation for further details
SWEEP EXPANSION	30 cm
HORIZONTAL POSITIONING	Sufficient to position any full scale portion of the expanded sweep (30 cm) or X INPUT signal on the screen
BEAM GATE	See Horizontal Amplifier Specifications
SWEEP TRIGGER OUTPUT	Trigger signal of approximately 5 volts amplitude available at TRIGGER OUTPUT front-panel terminal. Internal dc resistance to ground is 220K ohms, ±10%, 1/2 watt. Trigger pulse is negative at start of sweep and positive at end.

SYNC CIRCUIT

SYNC SOURCE..... Positive or negative INTernal, power LINE, or EXTernal signals

SYNC SENSITIVITIES

a. Driven Sweep Can be Triggered by Signals Having the Following Characteristics:

1. Rate of rise

EXT.....80 volts/second minimum

INT..... 12.7 cm/second minimum

2. Duration 0.2 microsecond minimum

3. Amplitude

EXT.....2.5 volts peak-to-peak minimum

INT..... 1 cm of vertical deflection minimum

4. Sinusoidal signal..... Sine waves from 10 cps to 100 Kc with a minimum peak-to-peak voltage of less than 5 volts (EXT), 2 cm of vertical deflection (INT); and from 2 cps to 250 Kc with larger amplitude

b. Automatic Sweep.....Identical to Driven Sweep

INTENSITY MODULATION CIRCUIT

Z AXIS

a. Availability..... Z INPUT terminal is provided on rear panel for signal input. This terminal is returned to ground through a 2.2 megohm resistor

b. Input Impedance..... 10,000 ohms, 30 uuf minimum

c. Input Coupling..... Internally the Z-axis signal is coupled through a 0.01 uf capacitor to the cathode of the CRT

d. Polarity..... Positive signals decrease beam intensity; 2 to 56 volts peak-to-peak depending on INTENSITY setting, will blank the beam

POWER SUPPLY

POWER REQUIREMENTS

Three regulated power supplies are available for the following power sources

a. 60 cycles per second line at 115 volts ±10%, Input power 110 watts.

b. 50 cycles per second line at either 115 volts ±10% or 230 volts ±10%. Input power 110 watts.

c. 50 to 400 cycles per second line 115 volts ±10%. Input power 140 watts at 115 volts line.

HIGH VOLTAGE SUPPLY..... An electronically regulated rf supply system for generating CRT accelerating potentials is provided

PHYSICAL CHARACTERISTICS

	TYPE 401-A	TYPE 401-AR
Height	15-1/2 inches	8-3/4 inches
Width	8-3/4 inches	19 inches
Depth	21 inches	* 18-3/4 inches
Weight	45 pounds	45 pounds

* Measured from rear of front panel to rear end of instrument. Handles extend 1-1/2 inches in front.

AVAILABLE DU MONT ACCESSORIES

Below is a list of Du Mont accessories that can be used with the Type 401-A Oscilloscope. Refer to Du Mont's catalog of Components and Accessories for detailed information on specifications and prices. In addition to the items listed below, Du Mont has a complete line of cameras for moving film and single-frame oscilloscopic recording.

Type or Part Number	Description
4800 4511	Color filter, green
4800 4512	Color filter, blue
4800 4513	Color filter, amber
316	Attenuator Probe
2507	Attenuator Probe
2609	Detector Probe
2613	Attenuator Probe (used with Type 2592-BØ Terminal Adapter
3010	Five-inch insulated probe tip for Type 2613 Probe
3004 0311	Hook-on tip for Type 2613 Probe
3600 5751	Insulated alligator tip for Type 2613 Probe
5101 6671	Needle-nose tip for Type 2613 Probe
2601-A	Movable Table, non-adjustable shelf
2602	Movable Table, adjustable shelf
2592-BØ	Terminal Adapter, unterminated, equipped with BNC receptacle
276-B or 276-C	Viewing Hood

While many of the adjustments listed can be set independently, it should be noted that they should be adjusted in the order presented. At least, all those in any one section should be adjusted as described in order.

ELECTRONIC-REGULATED LOW VOLTAGE SUPPLY

Control	Test Equipment	Procedure
+390 V ADJUST R1616	1.	Place the meter between the +390 volt output and ground; across C1608 is suggested. Adjust +390 V ADJUST R1616 for +390 volts on the meter.

2. HIGH VOLTAGE SUPPLY AND CRT

Control	Test Equipment	Procedure
HV ADJUST R501	1.	Set INTENSITY fully counterclockw Use an insulated test probe and ad- just the high-voltage negative sup to -1300 volts. Measurement may be made conven between counterclockwise end of INTENSITY control and ground.
ASTIGMATISM R401	--	Set appropriate front-panel control to obtain spot on screen. Adjust ASTIGMATISM R401 simul- taneously with FOCUS control for minimum spot size at normal IN- TENSITY setting.

Control	Test Equipment	Procedure
		When properly adjusted, the spot will always be round as the FOCUS control is rotated both clockwise and counterclockwise from the sharpest FOCUS setting.

VERTICAL AMPLIFIER

Control	Test Equipment	Procedure
Y VOLTS/CM Compensation Capacitors C106, C107, C108	2.	Apply a 10-Kc square wave to Y input. Set the Y VOLTS/CM switch as listed below. Adjust the appropriate capacitor to obtain a flat-top square wave.

Y VOLTS/CM	Adjust
0.1	C106
1.0	C107
10	C108

V102 BIAS R121 V103 BIAS R125	1. & 2.	Set Y CAL button in. Set Y VOLTS/CM to OFF. Adjust V102 BIAS R121 for maximum gain. This is a preliminary setting to permit proper astigmatism adjustment and to minimize variations when the square wave is applied. Readjust ASTIGMATISM control as described in 2. HIGH VOLTAGE SUPPLY AND CRT on a previous page. *Set Y CAL button out. Set V103 BIAS R125 for +265 volts with spot centered as measured on D3 or D4 terminals on rear deflection plate panel. ** Apply a 10-Kc square wave at 5 volts peak-to peak into the Y input. Set Y VOLTS/CM to 1.0 A-C.

Control	Test Equipment	Procedure
		Set Y AMPLITUDE control for 3 cm of deflection. Set Y VOLTS/CM to 0.1 A-C. Adjust V102 BIAS R121 for a minimum change of peaking with a change in positioning. * Repeat section from * to * twice, starting at ** the second time.
Y LINEARITY R128	2.	Apply a 10-Kc square wave into the Y input. Set Y VOLTS/CM and Y AMPLITUDE to obtain 1 cm of vertical deflection near the center of the screen. Use the Y POSITION control to move the trace to the upper and lower limits of the screen. The deflection linearity should not change by more than 5%. If it does, move Y LIN R128 in small increments until such positioning indicates a linearity better than 5%. If such linearity cannot be achieved within the extreme positions of the Y LIN control, replace V103 and repeat procedure.
Y 50 MV R612 (R1633)	3.	Set Y VOLTS/CM to .01 D-C. Apply a 0.05-volt, $\pm$1%, signal from an external voltage calibrator to Y input. Advance Y AMPLITUDE for a vertical deflection of half scale. Use the half-scale marks provided on the scale Y axis. Set Y CAL button in. Adjust Y 50 MV R612 (R1633) for the same half-scale deflection.

HORIZONTAL AMPLIFIER

Control	Test Equipment	Procedure
X VOLTS/CM Compensation Capacitors C306, C307, C308	2.	Apply a 10-Kc square wave to X input. Set the X VOLTS/CM switch as listed below. Adjust the appropriate capacitor until the dots at each end of the horizontal trace are of maximum relative intensity and in sharpest focus. X VOLTS/CM — Adjust 0.1 — C306 1.0 — C307 10 — C308
V302 B1AS R321 V303 B1AS R325	1. & 2.	Set X CAL button in. Set X VOLTS/CM to OFF. Adjust V302 B1AS R321 for maximum gain. This is a preliminary setting to permit proper astigmatism adjustment and to minimize variations when the square wave is applied. If it has not already been adjusted during the settings of the Vertical Amplifier, readjust the ASTIGMATISM control as described in 2. HIGH VOLTAGE SUPPLY AND CRT on a previous page. * Set X CAL button out. Set V303 B1AS R325 for +265 volts measured on D1 and D2 terminals on rear deflection plate panel. ** Apply a 10-Kc square wave at 5 volts peak-to-peak into the X input. Set X VOLTS/CM to 1.0 A-C. Set X AMPLITUDE control for 3 cm of deflection. Set X VOLTS/CM to 0.1 A-C.

Control	Test Equipment	Procedure
		Adjust V302 BIAS R321 for a minimum change of peaking with a change in positioning. * Repeat section from * to * twice, starting at ** the second time.
X LINEARITY R328	2.	Apply a 10-Kc square wave into the X input. Set X VOLTS/CM and X AMPLITUDE to obtain 1 cm of horizontal deflection near the center of the screen. Use the X POSITION control to move the trace to the upper and lower limits of the screen. The deflection linearity should not change by more than 5%. If it does, move X LIN R328 control in small increments until such positioning indicates a linearity better than 5%. If such linearity cannot be achieved within the extreme positions of the X LIN control, replace V303 and repeat procedure.
X 50 MV R614 (R1634)	3.	Set X VOLTS/CM to .01 D-C. Apply a 0.05-volt, ±1%, signal from an external voltage calibrator to X input. Advance X AMPLITUDE for a horizontal deflection of half scale. Use the half-scale marks provided on the scale X axis. Set X CAL button in. Adjust X 50 MV R614 (R1634) for the same half-scale deflection.

HUM BALANCING

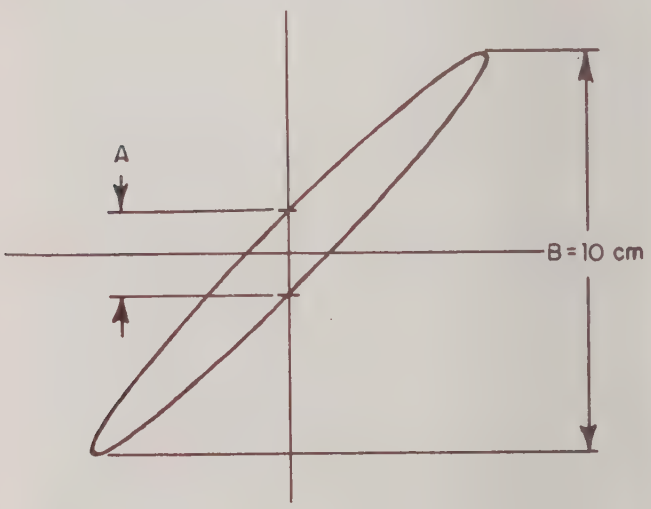
Control	Test Equipment	Procedure
HUM BAL R603 (R1603) X & Y HUM R107, R307		Set X and Y AMPLITUDE controls fully clockwise without actuating CAL switches. Set X and Y VOLTS/CM switches to .01 D-C. Shield X and Y input terminals. The power line ripple should not exceed 1 mm of screen deflection. If it does, adjust HUM BAL R603 (R1603), and X and Y HUM R107, R307 controls for minimum deflection.

PHASE BALANCING

Control	Test Equipment	Procedure
PHASE BAL C121, C321	2. & 5.	Set Y VOLTS/CM to .01 D-C. Set Y AMPLITUDE fully clockwise without actuating CAL switch. Set X VOLTS/CM to .01 D-C. Set X AMPLITUDE fully clockwise without actuating CAL switch. Set PHASE BAL C121, C321 to minimum capacity (pool of solder on rotor turned away from power supply). Apply 10-Kc square wave to both the X and Y inputs. Adjust output of generator to obtain 8 cm Y deflection. The resulting X deflection will be between 5 and 7-1/2 cm depending upon gain and CRT sensitivity. Adjust PHASE BAL C121, C321 to obtain the following pattern on the screen.

Control	Test Equipment	Procedure

To check the relative phase shift, apply a 100-Kc sine wave to both the X and Y inputs. The pattern obtained should be as shown below.



DIMENSION "A" SHOULD NOT EXCEED 5mm (3° FROM SIN θ = A/B).

At or below 5-Kc sinewave input, the phase shift should not exceed 1-3/4 mm (1°) for any combination of AMPLITUDE control and VOLTS/CM switch settings.

DEFLECTION PLATE NEUTRALIZER

Control	Test Equipment	Procedure
NEUTRALIZER C322	2.	Apply 10-Kc square wave to Y input. Set Y VOLTS/CM and Y AMPLITUDE for 10 cm vertical deflection. Set X VOLTS/CM to OFF. Adjust NEUTRALIZER C322 for minimum horizontal deflection.

SWEEP CIRCUITS

Control	Test Equipment	Procedure
Alignment of SYNC LEVEL knob to zero marking	--	Set X VOLTS/CM to AUTO. Set Y VOLTS/CM to 10 D-C. Set SWEEP RANGE to 2 MS/CM Set VERNIER fully clockwise to X1. Set SYNC switch to LINE. Set Y CAL button in. Adjust the X and Y AMPLITUDE and position the trace to occupy a square of about 4 cm in the center of the screen. At the zero marking of the SYNC LEVEL control the waveform should not be in sync. Rotate this control first towards "-" and then "+" until the waveform is in sync. Note the knob position in each case. For an accurate zero setting, these two positions should be symmetrical about the zero point. If not, loosen the knob set screw and reset the knob on the shaft so that it is aligned with the "O" marking when the shaft position is midway between the two "in-sync" points determined above.

Control	Test Equipment	Procedure
GATE SENS R226	--	Set DURATION R245 to center of range. Set GATE SENS R226 fully counter-clockwise. Set TRIG LEVEL R211 to center of range. Set SWEEP EXPANSION POINT to center of range. Set SYNC switch to EXT. Set SYNC LEVEL fully clockwise. Set X VOLTS/CM to AUTO. Advance GATE SENS R226 slowly clockwise until the sweep starts, then turn it a quarter turn (90°) past this point.
TRIG LEVEL R211	--	Set Y CAL button in. Set Y AMPLITUDE for 2 cm of vertical deflection. Set SYNC switch to INT. Set X VOLTS/CM to DRIV. Adjust TRIG LEVEL R211 so that the calibrator signal starts at the middle of its vertical rise.

SWEEP CALIBRATION

Control	Test Equipment	Procedure
SWEEP OR X CAL R317	4.	Set SWEEP RANGE to 2 MS/CM. Set VERNIER fully clockwise to X1. Set X VOLTS/CM to DRIV. Set SYNC switch to INT. Set SYNC LEVEL fully clockwise. Set X AMPLITUDE fully clockwise and actuate CAL SWP switch. Apply a timing signal of 1000-us pulse to the Y input. Set Y VOLTS/CM and Y AMPLITUDE to obtain 1 cm of vertical deflection. Set SWEEP OR X CAL R317 to produce 2 timing pulse per cm.

Control	Test Equipment	Procedure
DURATION R245	4.	Adjust DURATION R245 for a sweep length of 10 cm.
CAL X5 R239	4.	Set VERNIER fully counterclockwise to X5. Apply a timing signal of 10,000-us pulses to the Y input. Adjust CAL X5 R239 to produce 1 timing pulse per cm.
Alignment of VERNIER knob to X2 dot	4.	Apply a timing signal of 1000-us pulses to the Y input. Adjust VERNIER to produce 4 timing pulses per cm. At this point, the VERNIER knob should be aligned with the X2 dot. If it is not, loosen the knob setscrew and align it with the dot without turning the control shaft. Tighten the setscrew again.
Sweep Trimmer C215	4.	Set SWEEP RANGE to 5 uS/CM. Set VERNIER fully clockwise to X1. Apply a timing signal of 10-us pulses to the Y input. Set Y AMPLITUDE to obtain 3 cm of vertical deflection. Using an insulated or non-metallic screwdriver, adjust Sweep Trimmer C215 to produce 1 timing pulse per 2 cm.

SWEEP EXPANSION POINT

Control	Test Equipment	Procedure
SWEEP EXPANSION POINT R249	--	Check that X Bal is properly adjusted; see Section 2-8, b, for details. Set X AMPLITUDE fully counterclockwise. Set SYNC switch to LINE. Set SYNC LEVEL fully clockwise. Set VERNIER fully clockwise to X1.

Control	Test Equipment	Procedure
		Set SWEEP RANGE to 2 MS/CM. Set Y CAL button in. Set Y AMPLITUDE to obtain 2 cm of vertical deflection.
		Left side expansion
		Adjust X POSITION to set vertical trace on screen under the left side scale marking. Set X AMPLITUDE fully clockwise without actuating switch. Using the SWEEP EXPANSION POINT R249, reposition the start of the now expanded trace under the left side scale marking.
		If the above adjustments have been made with care, the sweep will expand from the left side of the screen when the X AMPLITUDE control is rotated.
		Right side expansion
		Use the same procedure as above, except set the trace under the right side scale marking.
		Center expansion
		First make the initial settings as for the end expansions described above.
		Adjust X POSITION to set the vertical trace on the screen under the center scale marking. Adjust X AMPLITUDE to obtain 10 cm of horizontal deflection.

Control	Test Equipment	Procedure
		Using the SWEEP EXPANSION POINT R249, center the 10-cm deflection about the center scale marking. It may be necessary to set the X AMPLITUDE and SWEEP EXPANSION POINT controls together to make this adjustment. If the above adjustments have been made with care, the sweep will expand equally about the center marking of the scale when the X AMPLITUDE control is rotated.

ADJUSTMENTS TO BE MADE WHEN REPLACING TUBES

Symbol	Type	Adjustments to be Checked (See Tabel 4-2)
V101 & V102	ECC82/12AU7	V102 BIAS R121, Y HUM R107
V103	6BK7-B	V103 BIAS R125, Y LIN R128
V201	12AU7	TRIG LEVEL R211
V202 & V203	6U8	GATE SENS R226
V204	12AU7	DURATION R245, CAL X5 R239
V301 & V302	ECC82/12AU7	V302 BIAS R321, X HUM R307
V303	6BK7-B	V303 BIAS R325, X LIN R238
V401	5ADP-	ASTIG R401
V402	12AU7	NONE
V501	6AQ5	If circuit operated properly before tube failure, no adjustments should be required. Otherwise adjust HV ADJ R501.
V502	1X2-A	
V503	5642	
V504	6U8	
V601	5V4-G	Calibration controls
V602	OA2	Calibration controls
V603	6AL5	Check X 50 MV (R614) and Y 50 MV (R612) against a known standard. If no standard is available these controls should not be touched.
V1601	GZ-34	Calibration controls, +390 V ADJ (R1616)
V1602	6AU6-A	+390 V ADJ (R1616)
V1603	6BX7-GT	+390 V ADJ (R1616)
V1604	6CL6	NONE
V1605	6AL5	Check X 50 MV (R1634) and Y 50 MV (R1633) against a known standard. If no standard is available, these controls should not be touched.

SERVICING HINT CHART

NOTES: 1. This chart tabulates the following information:

a. Symptoms of tube or component failure.

b. Symptoms arising from misalignment of service adjustments; see Table 4-2 for the adjustment procedure.

2. Some of the symptoms indicated in this chart might be caused by failure of some component associated with the circuit under a analysis.

1. VERTICAL AMPLIFIER

	Symptom		Component or Adjustment to be Checked
1a.	No vertical deflection	1a.	V101 to V103
2a.	Y VOLTS/CM is set to OFF; trace shifts vertically with changes in setting of Y AMPLITUDE control	2a.	Y BAL (R112) See Section 2, Operation
3a.	Power-line frequency ripple noted on trace	3a.	HUM BAL (R603 (R1603)) and Y HUM (R107)
4a.	Size of pattern changes as it is positioned vertically on the screen	4a.	Y LIN (R128)
5a.	A 10-Kc square-wave signal is distorted at any one range of the Y VOLTS/CM switch	5a.	Y Compensation Capacitors (C106 to C108)
6a.	Relative phase shift is greater than normal	6a.	Phase Balance Trimmer (C121)
7a.	Y internal calibration voltage is either too high or too low	7a.	Y 50 MV (R612 (R1633))

SYNC AND SWEEP

	Symptom		Component or Adjustment to be Checked
1b.	No sync; instrument is set for AUTO sweep	1b.	V201 to V203. Refer to Table 1-1 for data on sync sensitivity
2b.	No sync; instrument is set for DRIVEN sweep; AUTO sweep is OK	2b.	TRIG LEVEL (R211), V201, and/or V202. Refer to Table 1-1 for data on sync sensitivity
3b.	No sweep; X VOLTS/CM set to SWEEP and SYNC set to INT	3b.	See 1c
4b.	No sweep; X VOLTS/CM set to SWEEP and SYNC set to INT; horizontal amplifier checks OK	4b.	GATE SENS (R226) and/or V201 to V204
5b.	Sweep length is less than 10 cm; instrument is set for calibrated sweep	5b.	DURATION (R245)
6b.	Sweep does not expand equally on either side of center when the X AMPLITUDE is varied	6b.	SWEEP EXPANSION POINT (R249)
7b.	All calibrated sweep writing rates are either too fast or too slow	7b.	SWEEP OR X CAL (R317)
8b.	Calibrated sweep writing rates are correct when VERNIER is set to X1, incorrect at X2	8b.	See Table 4-2 for alignment of VERNIER knob to X2
9b.	Calibrated sweep writing rates are correct at X1, incorrect at X5	9b.	CAL X5 (R239)

	Symptom	Component or Adjustment to be Checked
10b.	5 uS/CM calibrated sweep range out of tolerance; all other ranges are OK	10b. Sweep Trimmer (C215)
11b.	Error in writing rate noted on one or more portions of the screen	11b. E403 and/or V204
12b.	Undesired intensity modulation of trace noted when X VOLTS/CM is set for external signals	12b. Set SYNC to EXT and SYNC LEVEL to center of range. For further information, see "Gated Beam Operation" in Section 2
13b.	No sweep in any one range of the SWEEP RANGE control	13b.

SWEEP RATE set to	Defective Capacitor
50 MS/CM	C223
10 MS/CM	C222
2 MS/CM	C221
500 uS/CM	C219
100 uS/CM	C218
20 uS/CM	C217
5 uS/CM	C216 and/or C215

14b.	Undesired horizontal modulation of trace as illustrated below. Calibration signal shown.	14b. Neon bulb oscillating; check E201 or E403.

HORIZONTAL AMPLIFIER

	Symptom	Component or Adjustment to be Checked
1c.	No horizontal deflection; internal sweep circuit is normal	1c. V301 to V303
2c.	X VOLTS/CM is set to OFF; trace shifts horizontally with changes in setting of X AMPLITUDE control	2c. X BAL (R312)
3c.	Power-line frequency ripple noted on trace	3c. HUM BAL (R603 (R1603)) and X HUM (R307)
4c.	Size of pattern changes as it is positioned horizontally on the screen	4c. X LIN (R328)
5c.	A 10-Kc square-wave signal is distorted at any one range of the X VOLTS/CM switch	5c. X Compensation Capacitors (C306 to C308)
6c.	Relative phase shift is greater than normal	6c. Phase Balance Trimmer (C321)
7c.	All calibrated sweep writing rates are either too fast or too slow	7c. SWEEP OR X CAL (R317)
8c.	X internal calibration voltage is either too high or too low	8c. X 50 MV (R614 (R1634))

HIGH VOLTAGE SUPPLY, CRT AND BEAM GATE

	Symptom		Component or Adjustment to be Checked
1d.	No spot on cathode-ray tube screen	1d.	V401 and/or V503 also see 1a and 1c
2d.	Poor high-voltage regulation	2d.	V501 and/or V504
3d.	-HV output is too high or too low	3d.	-HV ADJ(R501)
4d.	Bright spot noted at left side of screen; visible return trace	4d.	V402
5d.	Non-uniform focused pattern as it is positioned over the screen	5d.	ASTIG (R401)

SOLA-REGULATED LOW VOLTAGE SUPPLY

	Symptom		Component Adjustment to be Checked
1e.	Dead unit; primary line fuse, F604 is OK	1e.	Heater fuse, F603 and/or B+ fuse F601
2e.	Dead unit; all fuses are OK	2e.	V601
3e.	Dead unit; all fuses and rectifier (V601)are OK	3e.	Refer to schematic and check P502 and J601
4e.	No calibrator pattern when X CAL and/or Y CAL buttons are pushed in	4e.	V603
5e.	Calibrator pattern rounded on top or bottom, looks like a sine wave	5e.	V603

	Symptom	Component or Adjustment to be Checked
6e.	Calibrated sweep writing rates and output of voltage calibrator flunctuates	6e. V602
7e.	Output voltages are very low	7e. C602. This capacitor has been selected to resonate with T601. If replacement is necessary, replace it with one having the same color dot stamped on the end of laminations (SOLA)
8e.	Output voltage varies; line voltage within tolerance	8e. T601 is intended for use with 60-cycle power line mains. Changes in the frequency of the supply voltage will be directly reflected in the output voltage. A change of about 1.8% in output voltage will occur for every 1% change in input frequency, and in the same direction as the frequency change

ELECTRONIC-REGULATED LOW VOLTAGE SUPPLY

	Symptom	Component or Adjustment to be Checked
1f.	Dead unit	1f. Primary fuse F1601, or V1601
2f.	+390 V incorrect, +390 V ADJUST cannot correct	2f. Defective V1603, V1602, V1606
3f.	+390 V OK, but +150 V incorrect	3f. Defective V1604
4f.	No calibrator pattern when X CAL and/or Y CAL buttons are pushed in	4f. V1605

	Symptom		Component or Adjustment to be Checked
5f.	Calibrator pattern rounded on top or bottom, looks like a sine wave	5f.	V1605
6f.	Calibrated sweep writing rates and output of voltage calibrator flunctuates	6f.	V1604

COMPONENT PARTS LISTS

ELECTRICAL

Symbol Numbering System:

100 Series - Vertical Amplifier
200 Series - Sync and Sweep
300 Series - Horizontal Amplifier
400 Series - Indicator and Beam Gate
500 Series - High Voltage Supply
600 Series - Sola-Regulated Low Voltage Supply
1600 Series - Electronic-Regulated Low Voltage Supply

Symbol	Du Mont Part Number	Description
	CAPACITORS	(fixed, mica, ±10%, 500 V unless otherwise specified)
C101	0312 8220	paper, .1 uf, ±20%, 600 V
C102	0302 0480	270 uuf
C103	0302 9430	820 uuf
C104	0303 3650	8200 uuf
C105	0302 0820	24 uuf, ±5%
C106 to C108	0316 9631	variable, glass, 1-12 uuf, 600 V
C109	0301 9650	ceramic, .01 uuf, +80-20%, 450 V
C111	0301 9650	ceramic, .01 uf, +80-20%, 450 V
C112	0302 0390	47 uuf
C113	0301 3230	ceramic, 5 uuf, ±.5 uuf
C114 & C115	0315 2450	composition, .5 uuf, ±20%
C117 & C118	0315 2480	composition, 1.5 uuf, ±20%,
C119	0319 1615	paper, .1 uf, ±20%, 400 V
C121	0300 7790	variable, ceramic, 1.5-7 uuf
C201	0300 4170	paper, .05 uf, +20-10%, 600 V
C202	0302 0390	47 uuf
C203	0318 1000	electrolytic, 20 uf, +50-10%, 250 V
C204 & C205	0319 1535	paper, .47 uf, ±20%, 200 V
C206	0301 9650	ceramic, .01 uf, +80-20%, 450 V
C207	0313 8390	paper, .33 uf, 100 V
C208 & C209	0305 5520	22 uuf
C211	0305 5840	470 uuf, 300 V
C212	0302 0330	15 uuf

Symbol	Du Mont Part Number	Description
C213	0305 5750	200 uuf
C214	0302 0820	24 uuf, ±5%
C215	0300 3070	variable, ceramic, 4-30 uuf
C216	0302 0820	24 uuf, ±5%
C217	0326 0620	350 uuf, ±1%, 300 V
C218	0316 1570	1950 uuf, ±1%
C219	0318 7730	.01 uf, ±1%, 300 V
C221	0326 0610	.04 uf, ±1%, 300 V
C222	0319 0721	plastic, .2 uf, ±1%, 200 V
C223	0319 0712	plastic, 1 uf, ±1%, 200 V
C224	0326 1580	47 uuf, ±5%
C301	0312 8220	paper, .1 uf, ±20%, 600 V
C302	0302 0480	270 uuf
C303	0302 9430	820 uuf
C304	0303 3650	8200 uuf
C305	0302 0820	24 uuf, ±5%,
C306 to C308	0316 9631	variable, glass, 1-12 uuf, 600 V
C309	0301 9650	ceramic, .01 uf +80-20%, 450 V
C311	0301 9650	ceramic, .01 uf, +80-20%, 450 V
C312	0302 0390	47 uuf
C314 & C315	0315 2450	composition, .5 uf, ±20%
C317 & C318	0315 2480	composition, 1.5 uuf, ±20%
C321 & C322	0300 7790	variable, ceramic, 1.5-7 uuf
C401	0301 9650	ceramic, .01 uf, +80-20%, 450 V
C402	0316 4930	ceramic, .01 uf, +100-0%, 2 KV
C403	0316 8650	ceramic, 22 uuf, 2 KV
C404 & C405	0301 9650	ceramic, .01 uuf, +80-20%, 450 V
C406	0315 3750	ceramic, .005 uf, +100-0%
C501	0316 4930	ceramic, .01 uf, +100-0%, 2 KV
C503	0314 6090	ceramic, 1.5 uuf, ±.5 uuf, 5 KV
C504	0319 1615	paper, .1 uf, ±20%, 400 V
C505	0316 4930	ceramic, .01 uf, +100-0%, 2 KV
C601	0312 6030	electrolytic, 40 x 80 x 20, +50-10%, 450 V
C602	--	paper, .85 uf nominal, 850 V (matched to T601)
C603	0315 7590	electrolytic, 50 uf, +50 -10%, 250 V
C604 & C605	0319 1531	paper, .1 uf, ±20%, 200 V
C609 & C610 C1609 & C1610	0301 9650	ceramic, 0.01 uf, +80 -20%, 450 V

Symbol	Du Mont Part Number	Description
C1601 & C1602	0301 4460	electrolytic, 125 uf, +50-10%, 350 V
C1603	0301 9650	ceramic, .01 uf, +80-20%, 450 V
C1604 & C1605	0319 1531	paper, .1 uf, ±20%, 200 V
C1606	0301 9260	paper, .1 uf, ±20%, 400 V
C1607	0315 7590	electrolytic, 50 uf, +50-10%, 250 V
C1608	0301 4710	electrolytic, 10 uf, +75-10%, 450 V
	RECTIFIERS	
CR201 & CR202	2600 0940	1N54A
CR203	2600 1530	1N34A
	LAMPS	
DS601	1200 1370	incandescent, bayonet, .25 ampere
DS602 to DS605	1201 0960	incandescent, bayonet, .16 ampere
DS1601	1200 1370	incandescent, bayonet, .25 ampere
DS1602 to DS1605	1201 0960	incandescent, bayonet, .16 ampere
	REGULATORS	
E201	1200 9051	lamp,neon, bayonet
E401 & E402	1200 8931	lamp,neon
E403	1200 9051	lamp, neon, bayonet
	FUSES	
F601	1100 0900	2/10 ampere, slow blow
F603	1100 0820	8 amperes
F604	1100 0780	2 amperes
F1601	1100 0780	2 amperes
	RECEPTACLES	
J501	0905 4900	jack, tip, black
J503	0900 7200	jack, tip, red
J601	0905 0380	female, 5 pins
J1601	0905 0380	female, 5 pins

Symbol	Du Mont Part Number	Description
	INDUCTORS	
L201	2101 6951	fixed, 680 uh, ±5%
L501	2100 3810	fixed, 9.1 mh
L601	2101 7281	fixed, 10 h
	CONNECTORS	
P501	0905 0130	plug, tip, black
P502	0905 0370	male, 5 pins
P503	0900 7310	plug, tip, red
	RESISTORS (fixed, composition, ±10%, 1/2 watt, unless otherwise spcified)	
R101	0221 8450	film, 2M ohms, ±1%
R102	0221 8440	film, 250K ohms, ±1%
R103	0221 8430	film, 20.4K ohms, ±1%
R104	0221 8420	film, 2K ohms, ±1%
R105	0221 8450	film, 2M ohms, ±1%
R106	0204 1270	2M ohms, ±5%
R107	0106 6190	variable, 10K ohm, ±20% (Y HUM)
R108 & R109	0203 2560	220K ohms
R111	0203 0490	1100 ohms
R112	0105 6070	variable, 250 ohms, ±20%, (Y BAL)
R113 & R114	0228 6370	film, 121K ohms, ±1%
R115	0203 1780	1200 ohms
R116	See S103	
R117	0108 1380	variable, 25K ohms, ±20%, 2 W (Y CAL)
R119	0228 6590	film, 9100 ohms, ±1%, 1 W
R121	0108 1550	variable, 2500 ohms, ±20%, 2 W (V102 BIAS)
R122	0101 1410	variable, 500 ohms, ±20% (Y POS)
R123 & R124	0203 3960	100K ohms, ±5%, 1 W
R125	0103 3260	variable, 5K ohms, ±20%, 2W (V103 BIAS)
R126	0203 6740	12K ohms, ±5%, 2 W
R127	0203 6820	27K ohms, ±5%, 2 W
R128	0103 3270	variable, 10K ohms, ±20%, 2 W (Y LIN)

Symbol	Du Mont Part Number	Description
R129	0203 3730	11K ohms, ±5%, 1 W
R131	0203 6770	16K ohms, ±5%, 2 W
R132	0203 2210	4.7M ohms
R201	0203 2170	2.2M ohms
R202	0203 1850	4700 ohms
R203	0203 1890	10K ohms
R204	0203 1800	1800 ohms
R205	0203 1880	8200 ohms
R206	0101 4200	variable, 200K ohms, ±20%, ((SYNC) LEVEL)
R207	0203 2050	220K ohms
R208	0203 2010	100K ohms
R209	0228 5490	film, 250K ohms, ±1%
R211	0107 2280	variable, 25K ohms, ±20%, .3 W (TRIG LEVEL)
R212	0228 6030	film, 330K ohms, ±1%
R213	0203 0600	3300 ohms, ±5%
R214	0203 0650	5100 ohms, ±5%
R215	0203 0630	4300 ohms, ±5%
R216	0228 6030	film, 330K ohms, ±1%
R217	0203 1270	2M ohms, ±5%
R218	0228 5570	film, 500K ohms, ±1%
R219	0203 0880	47K ohms, ±5%
R221	0203 1980	56K ohms
R222	0203 1810	2200 ohms
R223	0203 0720	10K ohms, ±5%
R224	0203 0810	24K ohms, ±5%
R225	0228 6210	film, 1.3M ohms, ±1%
R226	0108 1550	variable, 2500 ohms, ±20%, 2 W (GATE SENS)
R227	0228 6150	film, 1M ohms, ±1%
R228	0203 1050	240K ohms, ±5%
R229	0203 0720	10K ohms, ±5%
R231	0203 0810	24K ohms, ±5%
R232	0228 6640	film, 43K ohms ±1%, 1 W
R233	0228 5770	film, 27K ohms, ±1%
R234	0203 1840	3900 ohms
R235	0203 5050	220K ohms, 1 W
R236	0228 5630	film, 600K ohms, ±1%
R237	See S202	
R238	0203 1350	4.3 M ohms, ±5%
R239	0107 1614	variable, 2M ohms, ±20%, 2 W (CAL X5)

Symbol	Du Mont Part Number	Description
R241	0203 1770	1K ohms
R242	0233 2590	wire wound, 22K ohms, ±1%, 7 W
R243	0203 0590	3K ohms, ±5%
R244	0203 1770	1K ohms
R245	0108 1550	variable, 2500 ohms, ±20%, 2 W (DURATION)
R246	0228 6540	film, 11K ohms, ±1%, 1 W
R247	0203 6930	75K ohms, ±5%, 2 W
R248	0203 0430	620 ohms, ±5%
R249	0107 2280	variable, 25K ohms, ±20%, .3 W (SW. EXP. PT.)
R251	0203 2090	470K ohms
R301	0221 8450	film, 2M ohms, ±1%
R302	0221 8440	film, 250K ohms, ±1%
R303	0221 8430	film, 20.4K ohms, ±1%
R304	0221 8420	film, 2K ohms, ±1%
R305	0221 8450	film, 2M ohms, ±1%
R306	0204 1270	2M ohms, ±5%
R307	0106 6190	variable, 10K ohms, ±20%, (X HUM)
R308 &309	0203 2560	220K ohms
R311	0203 0490	1100 ohms
R312	0105 6070	variable, 250 ohms, ±20% (X BAL)
R313 & R314	0228 6370	film, 121K ohms, ±1%
R315	0203 1780	1200 ohms
R316	See S303	
R317	0108 1380	variable, 25K ohms, ±20%, 2 W (X CAL)
R318	0203 1780	1200 ohms
R319	0228 6590	film, 9100 ohms, ±1%, 1 W
R321	0108 1550	variable, 2500 ohms, ±20%, 2 W (V302 BIAS)
R322	0101 1410	variable, 500 ohms, ±20% (X POS)
R323 & R324	0203 3960	100K ohms, ±5%, 1 W
R325	0103 3260	variable, 5K ohms, ±20%, 2 W (V303 BIAS)
R326	0203 6740	12K ohms, ±5%, 2 W
R327	0203 6820	27K ohms, ±5%, 2 W
R328	0103 3270	variable, 10K ohms, ±20%, 2 W (X LIN)

Symbol	Du Mont Part Number	Description
R331	0203 6820	27K ohms, ±5%, 2 W
R401	0106 7910	variable, 200K ohms, ±20%, 2 W (ASITG)
R402	0203 2170	2.2M ohms
R403	0203 1890	10K ohms
R404	0203 2030	150K ohms
R405	0203 1950	33K ohms
R406	0107 1371	variable, 250K ohms, ±20%, (INTENSITY)
R407	0203 2090	470K ohms
R408	0203 1030	200K ohms, ±5%
R409	0203 1940	27K ohms
R411	0203 2030	150K ohms
R412	0203 2090	470K ohms
R413	0203 8160	1.8M ohms, 2 W
R414	0203 2030	150K ohms
R415	0107 1372	variable, 5M ohms, ±20% (FOCUS)
R416	0203 2170	2.2M ohms
R417	0203 8210	4.7M ohms, 2 W
R418	0203 5100	560K ohms, 1 W
R419	0203 2050	220K ohms
R501	0101 8410	variable, 1M ohms, ±20% (HV ADJ)
R502	0210 0690	wire wound, 1.5 ohms
R503	0203 6600	3300 ohms, ±5%, 2 W
R504	0203 2090	470K ohms
R505	0203 8290	22M ohms, 2 W
R506	0210 0570	wire wound, .47 ohm
R508	0228 7570	film, 10M ohms, ±5%, 1 W
R509	0203 8290	22M ohms, 2 W
R510	0228 6800	film, 2.7M ohms ±1%, 1 W
R511	0210 9380	wire wound, 25K ohms, ±5%, 5 W
R512	0203 1980	56K ohms
R513	0203 2030	150K ohms
R601	0203 1960	39K ohms
R602	0203 1940	27K ohms
R603	0106 6090	variable, 500 ohms, ±20% (HUM BAL)
R604	0203 1930	22K ohms
R605	0203 8130	1M ohms, 2 W
R606	0203 1690	220 ohms
R607	0203 8070	330K ohms, 2 W

Symbol	Du Mont Part Number	Description
R608	0203 4800	1800 ohms, 1 W
R609 & R610	0203 2120	820 ohms
R611	0203 1890	10K ohms
R612	0105 3700	variable, wire wound, 1K ohms, 2 W (Y 50 MV)
R613	0203 1890	10K ohms
R614	0105 3700	variable, wire wound, 1K ohms, 2 W (X 50 MV)
R615	0203 8060	270K ohms, 2 W
R616	0210 6330	wire wound, 7500 ohms, ±5%, 10 W
R617/S601	0107 1631	variable, wire wound, 50 ohms, 2 W (SCALE) including S601 switch (POWER)
R618 & R619	0203 0430	620 ohms, ±5%
R620 & R621	0203 1710	330 ohms
R1601	0203 1960	39K ohms
R1602	0203 1940	27K ohms
R1603	0106 6090	variable, 500 ohms, ±20% (HUM BAL)
R1604	0203 6090	24 ohms, ±5%, 2 W
R1605 & R1606	0203 8010	100K ohms, 2 W
R1607	0203 7130	510K ohms, ±5% 2 W
R1608	0203 1000	150K ohms, ±5%
R1609	0203 4080	330K ohms, ±5% 1 W
R1610	0203 2130	1M ohms
R1611	0210 6270	wire wound, 25K ohms, ±5%, 10 W
R1612 & R1613	0203 1730	470 ohms
R1615	0228 6150	film, 1M ohms, ±1%
R1616	0105 7880	variable, 100K ohms (+390 V ADJ)
R1617/S1601	0107 1631	variable, wire wound, 50 ohms, 2 W (SCALE) including S1601 switch (POWER)
R1618	0228 5580	film, 540K ohms, ±1%
R1619 & R1620	0203 1590	33 ohms
R1621	0228 5640	film, 667K ohms, ±1%
R1622	0228 5510	film, 380K ohms, ±1%
R1623	0210 6260	wire wound, 20K ohms, ±5%, 10 W
R1624	0203 8130	1M ohms, 2 W
R1625	0203 1930	22K ohms
R1626	0203 8060	270K ohms, 2 W
R1627 & R1628	0203 2120	820K ohms
R1629 & R1630	0203 1890	10K ohms

Symbol	Du Mont Part Number	Description
R1631 & R1632	0203 1710	330 ohms
R1633	0105 3700	variable, wire wound, 1K ohms, 2 W (Y 50 MV)
R1634	0105 3700	variable, wire wound, 1K ohms, 2 W (X 50 MV)
R1635 & R1636	0203 0430	620 ohms, ±5%
R1637 & R1638	0228 7480	wire wound, 7K ohms, ±5%, 20 W
	CURRENT REGULATOR	
RT1601	0228 7500	
	SWITCHES	
--	0501 4891	Assembly
consisting of:		
S101	0501 4892	rotary, 3 decks, 9 positions (Y VOLTS/CM)
R116/S103	0107 1621	Resistor, variable, composition, 25K ohms, ±20%, 1/4 W (Y AMPLITUDE) including S103 switch (CAL)
--	0501 3091	Assembly
consisting of:		
S301	0501 3092	rotary, 5 decks, 11 positions (X VOLTS/CM)
R316/S303	0107 1621	Resistor, variable, composition, 25K ohms, ±20%, 1/4 W (X AMPLITUDE) including S303 switch (CAL)
--	0501 3101	Assembly
consisting of:		
S202	0501 3102	rotary, 2 decks, 7 positions (SWEEP RANGE)
R237	0106 4910	Resistor, variable, composition, 5M ohms, ±20%, 1/2 W (VERNIER)

Symbol		Du Mont Part Number	Description
S101		See 0501 4891	Switch Assembly above
S102		0500 6793	push-push (Y CAL)
S103		See 0501 4891	Switch Assembly above
S201		0500 9662	rotary, 1P3T (SYNC)
S202		See 0501 3101	Switch Assembly above
S301		See 0501 3091	Switch Assembly above
S302		0500 6793	push-push (X CAL)
S303		See 0501 3091	Switch Assembly above
S601		See R617/R601	
S1601		See R1617/S1601	
		TRANSFORMERS	
T501		2000 7311	High Voltage
T601		2000 9891	Power (60 cps, 115 volts)
	or	2001 0881	Power (50 cps, 115/230 volts)
T1601		2001 2061	Power (50 to 400 cps, 115 volts)
		TUBES	
V101 & V102		2501 1610	ECC82/12AU7 (Yellow)
V103		2501 1540	6BK7-B
V201		2500 0130	12AU7 (Red)
V202 & V203		2501 1840	6U8-A
V204		2500 0130	12AU7 (Red)
V301 & V302		2501 1610	ECC82/12AU7 (Yellow)
V303		2501 1540	6BK7-B
V401		2500 7390	5ADP1, medium persistence, green
	or	2500 7400	5ADP2, long persistence, blue-green
	or	2500 7420	5ADP7, long persistence, yellow
	or	2500 7430	5ADP11, short persistence, blue
V402		2500 0130	12AU7

Symbol	Du Mont Part Number	Description
V501	2500 0340	6AQ5
V502	2500 6490	1X2-A
V503	2500 5740	5642
V504	2501 1840	6U8A
V601	2501 1180	5V4-GA
V602	2500 0300	OA2
V603	2500 0020	6AL5
V1601	2501 1560	GZ34/5AR4
V1602	2501 1550	6AU6-A
V1603	2500 7810	6BX7-GT
V1604	2500 7820	6CL6
V1605	2500 0020	6AL5
V1606	2500 0300	OA2
	CABLE	
W601	5026 9641	Power
W1601	5026 9641	Power

MP MASTER
MA29967